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A Software System for Modeling Jobs and People Characteristics to Help Optimize Individual and Organizational Objectives

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Abstract

There is a critical need for the development of a general utility software package which would permit both policy capturing and policy specifying analyses through modeling of individual people characteristics and job properties (work states). Such software should be functional at multiple levels of abstraction: at an operational level, for person-job matching, and at an organizational planning level for executive assessment of alternative strategies for mission accomplishment or adaptation to changes. Planners and decision-makers need to be able to evaluate optimal ways of allocating available people to existing or anticipated work, and individuals need to order their preferences based on available or expected work and possible training. The needed software system would extend traditional person-job match technology to become a multi-level simulation and analysis system which could be potentially very useful in fuzzy budgeting or programming, and in planning for military to civilian conversions (individuals, units, bases, etc.). We strongly advocate an expeditious research & development effort for the design and tryout of such a software system.

Introduction

At last year's MTA conference in San Diego, some of us suggested that the ultimate key to individual and organizational productivity was a refined person-job matching system (Ward, Vaughan, Mitchell, Driskill, and Ruck, 1992). The necessary person-job matching technology and needed computer capacity has been available for some time (Ward, 1983; Ward, Haney, Hendrix, & Pina, 1978), but the explicit job requirements data base and the management will to use the technology has been lacking. There are a number of other things which can be done once comprehensive job requirements and people data bases are developed for a unit or organization. One could model and project future needs, based on the expressed career intent attitudes of current job incumbents. One could model any number of alternative job structures in terms of changes to jobs and associated training programs; the technology for this type of modeling is already available in the Training Decisions System (TDS) technology on a specialty by specialty basis (which is the subject of one of the other presentations in this symposium). Given additional information concerning future job applicant demographics, one could also model a variety of situations where jobs are reengineered to make the best use of the talents expected to be available, or to meet anticipated problems (reduced budget and manpower authorizations).

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14. ABSTRACT
There is a critical need for the development of a general utility software package which would permit both policy capturing and policy specifying analyses through modeling of individual people characteristics and job properties (work states). Such software should be functional at multiple levels of abstraction: at an operational level, for person-job matching, and at an organizational planning level for executive assessment of alternative strategies for mission accomplishment or adaptation to changes. Planners and decision-makers need to be able to evaluate optimal ways of allocating available people to existing or anticipated work, and individuals need to order their preferences based on available or expected work and possible training. The needed software system would extend traditional person-job match technology to become a multi-level simulation and analysis system which could be potentially very useful in fuzzy budgeting or programming, and in planning for military to civilian conversions (individuals, units, bases, etc.). We strongly advocate an expeditious research & development effort for the design and tryout of such a software system.

15. SUBJECT TERMS
Job modeling; Software systems; People characteristics; Policy capturing; Job properties; Person-job match; Organizational productivity; Individual productivity

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Modeling Individual Characteristics and Job Properties

The basic theoretical and mathematical tools for optimized person-job matching have been available for some time and are now being used to make initial assignments for Air Force guaranteed enlistment personnel in the Procurement Management Information System or PROMIS (Ward, 1983; Ward, Haney, Hendrix, & Pina, 1978). Other U.S. uniformed services have applied similar models (Kroeker, 1989). The difficulties have been in assembling the detailed person and job data bases and in the shear magnitude of the computations required for person-job matching. As we discussed last year, much more sophisticated and detailed data are becoming available concerning job requirements, including data concerning specific tasks and task modules that job incumbents will need to perform. Similarly, much more detailed data are becoming available concerning personnel characteristics, including specific task/task module proficiency data.

The first step in building the ultimate person-job matching system is to define an objective function. This mathematical function quantifies the relative value or utility of placing a given person into a specific job. Its independent variables will be person and job characteristics that predict or lead to the relative value of an assignment. A given person-job match may have different values, when viewed from different perspectives. One type of value relates to a person's productivity in a given job. This value would probably be maximized by improving the match between a person's current task proficiencies and a job's required tasks. Another type of value might relate to a person's preference for a particular job or assignment. This might involve such variables as geographic locationwhich are unrelated to job task performance requirements. A third type of value might relate to expansion of personal experience and skill, to prepare for future jobs.

The objective function reflects trade offs among these various (possibly conflicting) types of values associated with a person-job match. While this trade can be mathematically reflected in a variety of ways, perhaps the simplest involves a weighted linear function of measures for the different values. Weights may also be required within a single value measure. For example, some tasks in a job may be more important for overall job productivity than other tasks. These tasks should receive more weight in scoring the match between a person's task proficiency and a job's task requirements. Similarly, achieving a good match may be more important for some jobs than for other jobs; these jobs can be weighted more heavily in the overall value measure.

A key aspect in the success of a person-job matching system involves determining a set of weights that is acceptable to all parties. Such weights are subjective in nature and reflect a compromise between several different points of view. They can be determined using policy capturing and policy specifying methods (Ward, 1977). The next step in building the ultimate person-job matching system involves defining constraints that an acceptable organization-wide set of person-job matches must meet.

To model an entire organization involves aggregating specialty-specific data bases, or abstracting them in some way to represent the broader objectives or mission of the organization. At this level, organizational values or priorities can be entered into the system, as appropriate weights or constraints. Given that the right kinds of information are available, and some priorities established (in terms of which needs or requirements should be more heavily weighted), there is no reason that multiple functions cannot be used in an optimization algorithm. The mathematics required for such a system have been available for many years; the data bases needed, however, are just now being formulated. Such data bases are complex in terms of many variables and many data points, but are generally straightforward once the requirements have been defined.

Needed: A General Utility Software Package

With the higher order modeling, current job-specific person-job matching software and AFS-specific modeling technologies (i.e., TDS) are not adequate. A more general utility software package is needed which would facilitate both policy capturing and policy specifying analyses through modeling of general people characteristics and work states. To be most useful, such software should be able to function at multiple levels of abstraction. At an operational organization level, it could be used for person-job optimizing and at an organization level for executive planning and assessment of alternative strategies for accomplishing the unit mission or adapting to manpower or policy changes. At a more macro level, the software should be useful in modeling the implementation of major mission changes or organization restructurings; it should permit the specification of operational considerations or constraints expressed in terms of organizational goals or objectives.

Concept

To be useful, such a general utility software package should be functional at multiple levels of abstraction. It needs to be used for modeling person-job matching scenarios to meet real or hypothesized work requirements in an optimal way. At the same time, it must permit executive assessment of alternative strategies for mission accomplishment or for planning how to best meet organizational changes (driven by changes in budget, manpower, or mission requirements). Planners and decision-makers need to be able to evaluate optimal ways of allocating available people to existing or anticipated work; this involves development of a listing of jobs to be done in order of priority of work. In turn, the individuals in an organization need to be able to define and order their preferences based on available or expected work, and existing or potential job training (possible education and training courses which would enhance their job performance).

Such prioritized lists of work to be done (in mission priority order) and individual preferences (in order of preference) permit a new dimension in organizational person-job matching. Such dual listings permit joint optimization which will account for priority mission requirements and individual preferences at the same time. By utilizing individual preference information, such a person-job matching would tap the potential motivational advantages of giving consideration to such preferences. Thus, the probabilities are high that such a person-job matching would result in higher individual productivity and greater organizational mission accomplishment. The inclusion of both mission-oriented values and individual preferences in a joint optimization has the potential for significant improvement of both individual and organizational accomplishment.

While such an untraditional approach (of including individual preference functions as well as mission requirement priorities) is to be valued for its motivational potential, it may have even greater impact in the area of fuzzy logic. There are many times when decisions are made by assignments or education personnel which impact on the individual but over which the individual has no real control (phased attendance at Professional Military Education courses, or sporadic selection of individuals to attend FTD courses based on arbitrarily assigned quotas rather than specific job need). In situations where individual preferences are made a matter of record and those data are made available to decision-makers, then budgeting or programming decisions become at least a little less fuzzy, and some degree of arbitrariness is removed from the decision-making system. Individuals who feel they have some measure of control over their career and their organization are more apt to act as a member of the organization and not just a temporary employee.

The software needed for this type of activity must extend the traditional person-job match technology so that it can become a multi-level simulation and analysis system which will potentially be very useful in fuzzy budgeting and programming. Such a system could be very useful in planning for military to civilian conversions (individuals, units, bases, systems, etc.). To be useful at such varied organizational levels, the software much be designed to have a number of modeling utilities.

Software Development

Simulating every aspect of a real-world model as complex as the modern workplace would be fool-hearty, even if supercomputers were available. A more rational approach, however, is to develop a sound and robust model with integrated interdependencies (like a spreadsheet) which permits easy modification and rapid turnaround for targeted questions. In computer terms, the model should be "modularized" while in business terms the model is "organized." In addition, a complex model with separable components will lend itself to future near-full-scale modeling using the parallel processing computers on the horizon.

Theoretical Dimensions (Size, Situation, & Duration)

In order to design the model along reasonable modular boundaries, both the structural form (theoretical dimensions) and the process form (input-process-output) must be considered simultaneously. The target software package must work along three structural form dimensions: size, situation, and duration. The size dimension allows a differential focus from the individual job incumbent up through the organizational level models. This dimension requires person characteristics, organizational characteristics, and utility payoff functions for individuals in jobs. Note that the "job" is bridge from individual to organizational levels and the number, kind, and characteristics of jobs are organizational decisions.

The situational dimension permits differential focus on routine operations up through major internal or external forces affecting the situation. This dimension requires abstraction, depth, and robustness in the (individual or organizational) characteristic profiles. Once "routine" and "operational" characteristic profiles have been validated, aspects defining the situational perturbations would be addressed. To maximum extent possible, global parameters should be used to define a "field effect" rather than re-calibrating multiple variables in each individual and each organization in the simulation. Characteristic profiles should carry the individual's response disposition, but the environment ("the field") should trigger the response.

The duration dimension addresses the need to attend to both short-term simulations and long-term impact assessments. While a short-term simulation can afford to include greater detail and fidelity in modeling various situational contexts, long-term impacts can only reasonably be accomplished by broader based assumptions. A 20-year simulation cannot be derived by replicating a one month simulation 240 times -- different concerns arise as individuals and organizations change. As noted earlier, the system must allow both the individual and the organization to be goal-seeking entities, and hence each will seek to change any steady-state system. Long-term simulations must be able to address individual recruitment, training, career progression, early attrition, actualization, and retirement. For organizations, long-term simulations must be able to address start-up, growth operations, steady-state operations, external impacts (regulatory changes, market changes), internal reorganizations (product shift, restructuring for productivity, executive policy fiat, etc.), and decline operations (down-sizing, shut-down).

Process Dimensions (Input-Process-Output)

Organizations create structure and hire individuals with the expectation that those actions will produce the desired products. The criteria used to evaluate success in commercial endeavors is profitability. This model, however, is designed to apply beyond the business area so a secondary program evaluation model will be employed. In this methodology, one asks (in order) Is the system (1) effective?; (2) efficient?; and (3) aesthetic? Whether an organization is effective or not must be answered by external sources. This modeling system must incorporate a utility or payoff function for the organization's product(s). The same is true for individuals. The same is also true for intermediate organizational structures in the model such as work groups, branches, divisions, etc.

The second question, "Is the system efficient?" is a harder question to answer because one must assess not only the cost of inputs and the cost of processing, one must address the productivity of the processing units (people or machines) and assess them to other possible methods. In other words, they be effective (get the job done), but other existing methods could do that and cost less.

The third question, "Is the system aesthetic?", is designed to address issues of internal satisfaction of the individuals and the organization. In other words, in general, do members of the organization work as a team and find this a relatively nice place to work?

If the proposed modeling system address the scope outlined in the Theoretical Dimensions (Size, Situation, and Duration) and incorporate on-going assessments of utility from the Process Dimensions (Input-Process-Output)-- a great step forward will have been made in the quest to understand our modern workplace.

Conclusions

We strongly advocate an expeditious research and development effort for the design and tryout of a software system for modeling and people characteristics for optimizing individual and organizational objectives. Such a system is potentially extremely valuable for military decision-makers, particularly in these uneasy days of frequent reductions in manpower and budget where reprioritizing or restructuring the work to be done is a constant requirement. To make such decisions more reasonable and realistic, a system is needed to permit such decision-makers to understand their options and the potential impacts of their alternative decisions. Wherever possible, this kind of system should use existing database or some type of summary data compiled from such databases, since there is neither the time nor the money to collect new information each time a decision crisis occurs. Such software must include some type of internal tutorial assistance or extremely user-friendly interface so as to minimize the amount of external instruction or guidance needed. Any reasonably intelligent decision-maker who is knowledgeable in his or her functional or technical area, should be able to operate the system with minimal instruction.

This line of work is a natural evolution from the existing and successful person-job match technology; there are few technical risks in such a development effort. While there are some interesting modeling issues to be considered and solved, the general approach is both workable and highly practical. What is needed here is someone who can define this project as a critical requirement, and who can allocate sufficient funds to ensure its rapid accomplishment. A long-term research plan is not appropriate; this work needs to be done quickly if this type of system is to help in today's critical military Manpower, Personnel, and Training decision making as well as in civilian counterparts.

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